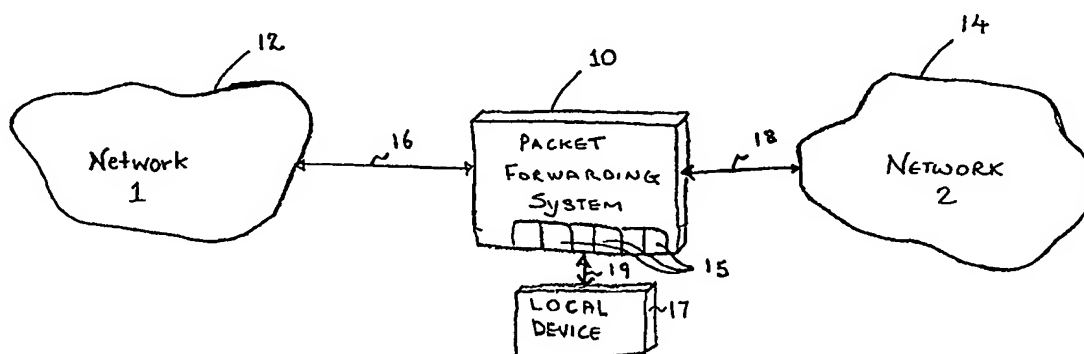




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<b>(21) International Application Number:</b> PCT/US99/28283 <b>(22) International Filing Date:</b> 30 November 1999 (30.11.99)  <b>(30) Priority Data:</b> 09/204,107      1 December 1998 (01.12.98)      US  <b>(71) Applicant:</b> 3COM CORPORATION [US/US]; 5400 Bayfront Plaza, Santa Clara, CA 95052-8145 (US).  <b>(72) Inventors:</b> ANDERSON, Pehr; 418 Columbus Avenue #3, Boston, MA 02116 (US). GADDA, Chris; 351 Massachusetts Avenue, Cambridge, MA 02139 (US).  <b>(74) Agents:</b> McGLEW, John, James et al.; McGlew and Tuttle, P.C., Scarborough Station, Scarborough, NY 10510-0827 (US).		<b>(81) Designated States:</b> AU, CA, JP, MX, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  <b>Published</b> <i>With international search report.</i> <i>With amended claims.</i>

(54) Title: TELECOMMUNICATION CONFERENCING SYSTEM AND METHOD



## (57) Abstract

A telecommunication conferencing system and method are described. Three or more telephone sets connected to one of the networks (12, 14) can concurrently participate in a conference call. Each telephone set engaged in the conference call receives a list of participants in the call and an identifier associated with that call. Each telephone set generates voice data packets that include the identifier and forwards the generated packets to the network. In one embodiment, the telephone set generates a unicast packet for each other telephone set engaged in the conference call. In another embodiment, the packets generated by the telephone set are multi-cast packets that include the identifier associated with the conference call. Each telephone set locally produces a combination of the packets received and outputs audio signals corresponding to the voice data of the combination.

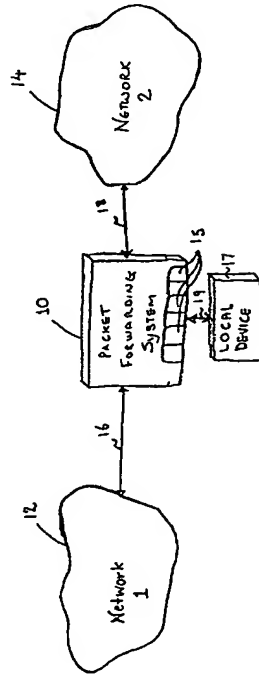
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industry has produced systems that integrate telephones and computers onto the same network. In such systems, telephones and computers share the same cabling infrastructure for transmitting voice data and computer data.

Advances in technology, though, continually increase the data rate capability of

5 networks. The Ethernet network, which is a prevalent type of local area network

(LAN), is an example. Devices (or nodes) connected to an Ethernet network

communicate with each other using packets having a structured format. The packets

include a destination address, a source address, and the data. Initially, the 10 Mbps

Ethernet network was the basis for the IEEE 802.3 standard, but Ethernet has since

10 evolved to support network data rates of 100 and 1,000 Mbps. While current

implementations of integrated telecommunication systems can adequately support

network data rates of an order of 10 Mbps, such systems cannot adequately provide

equivalent functionality at network speeds of 100 Mbps and beyond. This is due, in

part, to the use of hubs by current implementations of integrated telecommunication

15 systems to forward Ethernet packets on the LAN. A hub is a network device that

deposits Ethernet packets received on one communication path onto another

communication path. Many communication paths can meet at a hub. Because a hub

does not provide separate collision domains, the devices using these communication

paths compete against each other for use of the hub. A collision domain is a segment

20 of the LAN where a collision occurs when any two devices attempt to transmit packets simultaneously on that segment.

When a packet collision occurs on a segment, the devices sending the packets become alerted to the collision and "back off," that is, the sending devices wait a

## *TELECOMMUNICATION CONFERRING SYSTEM AND METHOD*

### *FIELD OF THE INVENTION*

The invention relates generally to an apparatus and method for integrating voice and data on a single telecommunication network. More specifically, the invention relates to a telecommunication apparatus and method for forwarding voice and data  
5 packets to the network on communication paths having separate collision domains.

### *BACKGROUND OF THE INVENTION*

Many modern businesses use two separate telecommunication networks for voice and for data. The costs associated with installing and maintaining two networks have induced some businesses to seek ways to integrate voice and data on a single  
10 telecommunication network infrastructure. As a result, the telecommunications

predetermined period of time before attempting to complete the transmission of the packets on that segment. The IEEE 802.3 standard specifies a back-off algorithm that each sending device must perform to be compliant with the standard when involved in a packet collision.

5 A problem, however, is that at high data rates (e.g., 100 Mbps data rates and beyond), a sending device can incorrectly deem a packet transmission to have been successful although that packet later encounters a collision after propagating through the network. Normally, at lower data rates (e.g., 10 Mbps), this collision causes the sending device to back-off on future attempts to transmit the packet. However, the 10 high data rates enable the sending device to complete the packet transmission before the collision occurs or is detected. Further, the sending device may even have continued to transmit other packets on that network segment. At high data rates, the propagation delay incurred in the network can prevent the timely detection of collisions and render the operation of the integrated telecommunication system 15 impracticable.

## SUMMARY AND OBJECTS OF THE INVENTION

In one aspect, the invention features a telephonic conferencing system comprising at least three telecommunication devices connected to a network and engaged in a concurrent telephonic communication. Each telecommunication device 20 includes an I/O device in electrical communication with the network, an input device for producing audio signals, and a packet controller in communication with the I/O device and the input device. The packet controller (a) generates packets from the

audio signals received by the input device, (b) forwards the generated packets to the I/O device for transmission to the network, and (c) combining packets received by the I/O device from the network for producing audio signals therefrom. Each telecommunication device can combine packets received from other telecommunication 5 devices known by that telecommunication device to be engaged in the concurrent telephonic communication. In other embodiments, the packets that are combined can be those packets received from at least one network and/or generated locally by the telecommunication device. Also, a portion of each packet can be selected for combination.

10 In one embodiment, the packets generated from the audio signals received by the input device can be unicast packets. The packet controller generates one unicast packet for each of the other telecommunication devices engaged in the concurrent telephonic communication. In another embodiment, the generated packets can be multi-cast packets. In another aspect, the invention features a telephonic conferencing 15 system comprising at least three telecommunication devices connected to a network and engaged in a concurrent telephonic communication. Each such telecommunication device receives an identifier that is associated with the concurrent telephonic communication. Each telecommunication device includes an I/O device in electrical communication with the network, an input device for producing audio signals, and a 20 packet controller in communication with the I/O device and the input device. The packet controller generates multi-cast packets from the audio signals received from the input device and forwards the generated multi-cast packets to the I/O device for transmission to the network. Each generated multi-cast packet includes the identifier

associated with the concurrent telephonic communication.

Each telecommunication device can combine multi-cast packets obtained from different sources. The multi-cast packets that are combined can be those packets received from one or more networks and/or generated locally by the telecommunication device. Also, portions of each multi-cast packet can be selected for combination.

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## BRIEF DESCRIPTION OF THE DRAWINGS

The invention is pointed out with particularity in the appended claims. The above and further advantages of the invention may be better understood by referring to 10 the following description in conjunction with the accompanying drawings, in which:

Figure 1 is a diagram of an embodiment of two separate networks connected by a packet forwarding system in which the invention is practiced;

Figure 2 is a diagram of an embodiment of the packet forwarding system of

Figure 1 coupled between a computer system and an Ethernet network;

15 Figure 3 is a diagram of an embodiment of the packet forwarding system of Figure 2, including a packet controller;

Figure 4 is a diagram of another embodiment of the packet forwarding system of Figure 2, including a packet switching device;

Figure 5 is a diagram of an embodiment of the packet controller of Figure 3;

20 and Figure 6 is a flow chart representation of an embodiment of a process by which packets are generated and queued within the packet forwarding system.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 shows a packet forwarding system 10 of the invention connected between a first network 12 and a second network 14 by electrical communication paths 16 and 18, respectively. Each of the networks 12, 14 can have any one of a variety of 5 communication topologies, e.g., a local area network (LAN) or a wide area network (WAN). In one embodiment, the packet forwarding system 10 is the only electrical connection between the network 12 and the network 14.

In Figure 1, each electrical communication path 16, 18 is a network segment that is part of a distinct collision domain. More specifically, the collision domain that includes the network 12 and the communication path 16 is separate from the collision domain that includes the network 14 and the communication path 18. According to the principles of the invention, the packet forwarding system 10 maintains the separation of the two collision domains.

The packet forwarding system 10 includes input/output (I/O) devices 15 for 15 transmitting signals to and receiving signals from a local device 17. In one

embodiment, the I/O devices 15 include a microphone, a keypad, and a telephone handset. Other I/O devices are possible, (e.g., a headset). The I/O devices 15 also include a liquid crystal display (LCD), light-emitting diodes (LEDs), speakers, and the telephone handset. Other types of I/O devices can be used to practice the invention.

20 The local device 17 can be any device capable of using the I/O devices 15 to receive signals from or transmit signals to the packet forwarding system 10 (e.g., a computer or a human operator). The packet forwarding system 10 can also include a first codec (not shown) coupled to the microphone and the speakers and a second codec (not

shown) coupled to the telephone handset for performing analog-to-digital and digital-to-analog conversions of audio signals.

According to the principles of the invention, the packet forwarding system 10 uses and/or forwards packets received from one of the networks to the other of the networks. More specifically, the packet forwarding system 10 uses and/or forwards packets received from the network 12 to the network 14 and uses and/or forwards packets received from the network 14 to the network 12. For example, some received packets may specifically target the packet forwarding system 10 (e.g., the destination address in such packets is the address for the system 10). In this event, the packet forwarding system 10 uses but does not forward these packets to one of the networks 12, 14. In another embodiment, the packet forwarding system 10 uses and forwards the packets. Other types of received packets, (e.g., broadcast packets), can be of interest to and used by the packet forwarding system 10.

Packets can also originate at the packet forwarding system 10, such as when a user places a telephone call. To place the telephone call, the user presses several keys on the keypad and speaks into the handset. The packet forwarding system 10 generates packets from the signals produced by the keypad and the handset and forwards the generated packets to either or both of the networks 12, 14. The contents of such packets depend upon the source of the signals. For the audio (i.e., voice) signals, the generated packets include voice data. For the digital signals produced by the keypad, the generated packets include control data. The packet forwarding system 10 can also initiate the generation of packets (e.g., to issue an alarm or other types of status packets).

As described further below, the packet forwarding system 10 may add a priority level to the packets, with the level of priority depending upon the type of data included in such packets. In general, there are at least two levels of priority. In one detailed embodiment, a packet has one of three levels of priority: high, medium, and nonprioritized (i.e., no priority given to the packet). In one embodiment, the level of priority effects the order in which the packet forwarding system 10 queues in memory the associated packets for transmission to one of the networks 12, 14. In another embodiment, the priority determines the order in which the packets are removed from memory when forwarding to one of the networks 12, 14.

The packet forwarding system 10 can detect when the networks 12, 14 are inadvertently connected to each other by a path other than through the packet forwarding system 10. In one embodiment, the packet forwarding system 10 periodically transmits a packet via one of the communication paths 16, 18 and determines whether that packet returns to the packet forwarding system 10 via the other communication path. In another embodiment, the packet forwarding system can determine that identical packets have arrived from both communication paths 16, 18 at almost the same time. The packet forwarding system 10 can display a warning on the LCD and disable communication via one of the two communication paths 16, 18 until the inadvertent connection is disconnected. Notwithstanding, it is to be understood that the principles of the invention can be practiced even though the networks 12, 14 are inadvertently connected.

Figure 2 depicts an exemplary embodiment of the packet forwarding system 10 as a telecommunication device 10 bridging two Ethernet networks 12 and 14.

Examples of telecommunication devices include a telephone set and a telephone line interface module (TLM) device. For exemplary purposes, the telecommunication device throughout the following description is a telephone set (hereafter, telephone set 10). The first network 12 is an Ethernet network including a file server 20, and the second network 14 is a computer system 14. The computer system 14 plugs into a receptacle of the telephone set 10. Thus, a single network infrastructure supports both computers and telephones. Although only one telephone set is shown, it should be understood that multiple telephone sets, each of which can be coupled to computer systems, can be similarly connected to the Ethernet network 12.

10 The computer system 14 can access the file server 20 through the packet forwarding operation provided by the telephone set 10. To request access to the server 20, the computer system 14 transmits Ethernet packets including the destination address of the server 20 to the telephone set 10 via the communication path 18. Upon receiving the packets, the telephone set 10 determines that the packets are not directed 15 to the telephone set 10, and queues the packets for transmission to the network 12 via communication path 16.

Concurrent with this request by the computer system 14, a user of the telephone set 10 may be holding a telephone conversation with the user of another telephone set (not shown) connected to the network 12. The audio signals enter the 20 telephone set 10 through one of the I/O devices 15, (e.g., the handset). From these audio signals, the telephone set 10 produces packets including voice data. Because voice data are timesensitive, (i.e., as time elapses the usefulness of the voice data decreases significantly), the telephone set 10 can give higher priority to packets

including voice data than packets including control data, such as the server request made by the computer system 14. Consequently, the telephone set 10 may preempt the transmission of the packets representing the server request and first queue the voice data packets for transmission.

5 While the telephone set 10 prepares to transmit the voice data packets to the network 12, voice data packets generated by the other telephone set engaged in the conversation may be received by the telephone set 10 via the communication path 16. The destination addresses in these voice data packets can indicate that the telephone set 10 is the targeted recipient. In this event, the telephone set 10 produces audio 10 signals from the voice data in the packets and outputs the audio signals to one of the I/O devices 15, (e.g., the handset). As a result, the user of the telephone set 10 hears the audio signals generated by the other user. The telephone set 10 can then discard the received voice data packets or forward the packets to the computer system 14.

The user of the telephone set 10 can engage in a "conference call" (i.e., a 15 conversation with users of two or more other telephone sets connected to the network 12). From audio signals produced by the user, the telephone set 10 generates packets including voice data. The telephone set 10 then transmits the generated packets to the network 12.

In one embodiment, each telephone set involved in the conference call receives 20 a list of all participants at the start of the conference call. This list of participants can be generated prior to the start of the conference call and can change as participants are added or dropped. The telephone set 10 generates a unicast packet for each other telephone set on the list of participants. For example, when the telephone set 10 is

engaged in a conference call with two other participants, the telephone set 10

generates two unicast packets having the same voice data and the telephone set 10 as the source address. The destination address in one of the two unicast packets is the address of one of the two other telephone sets, and the destination address in the second unicast packet is the other of the two other telephone sets.

In another embodiment, at the start of the conference call, each telephone set receives an identifier associated with the conference call. This identifier can be generated prior to the start of the conference call and can change during the conference call. The telephone set 10 generates multi-cast packets that include the identifier associated with the conference call. In each multi-cast packet, the telephone set 10 is the source address and the identifier can be the destination address.

The telephone set 10 uses only those packets from telephone sets known to be engaged in the conference call. For unicast packets, the source address of the received packets can be compared against the list of participants. For multi-cast packets, the identifier can indicate whether the packet came from a participant of the conference call.

When the telephone set 10 receives a packet, the telephone set 10 determines that the packet came from a participant in the conference call, produces audio signals corresponding to the voice data in the packet, and outputs the audio signals to the handset (or speaker). When multiple packets arrive at a telephone set from different sources, that telephone set combines the received packets and outputs audio signals corresponding to the voice data of the combination. The telephone set 10 can combine packets received from other telephone sets with packets generated by the telephone set

10 from locally received audio signals.

To produce the combination, the telephone set 10 can combine the voice data of the received packets or select for processing (i.e., producing audio signals from the voice data packets) one or more of the packets according to a predetermined criteria.

One criteria can be to process the packet with the voice data having the highest volume (i.e., loudest). The telephone set 10 can discard or forward unused voice data packets.

Figure 3 shows, in more detail, an exemplary embodiment of the telephone set 10. The telephone set 10 includes a packet controller 24 coupled to an input/output (I/O) port 26, two media access control (MAC) devices 28 and 32, memory 36, and I/O control circuitry 50. An outline 62 encloses those components 24, 26, 28, 32, and 50 that, in one embodiment of the invention, are disposed on an integrated circuit device (ASIC). It will be appreciated that other ASIC designs are possible, such as, for example, one in which the memory 36 is included on the ASIC.

The I/O port 26 is in electrical communication with the I/O devices 15, (i.e., the microphone, headset, or the handset), to receive audio signals from a user of the telephone set 10 and to transmit audio signals to the I/O devices 15, (e.g., the speaker or the handset), so that such signals are audible to the user. The I/O control circuitry 50 is coupled to I/O devices 15, (e.g., the keypad, the LCD, and the LED), to receive input signals from the keypad and to transmit control signals to the LCD and the LED.

The packet controller 24 is in electrical communication with the I/O port 26 by signal line 52 and with the I/O control circuitry 50 by signal line 53. The packet controller 24 is in electrical communication with the memory 36 via signal lines 35, with the MAC device 28 via signal lines 54, and with the MAC device 32 via signal



line 56 to control the transfer of packets between the memory 36 and the MAC devices 28 and 32. The packet controller 24 includes a timer 63.

In the embodiment, the MAC devices 28, 32 are 10/100 Ethernet ports capable of operating at a 100 Mbps network data rate. The MAC devices 28, 32 are the 5 physical interfaces for receiving and transmitting packets to the Ethernet networks 12, 14. Each MAC device 28, 32 provides a separate collision domain for packets being transmitted on the respective communication paths 16, 18. The first collision domain is the network segment that includes the MAC device 28 in electrical communication with the network 12 via communication path 16. The second collision domain includes 10 the MAC device 32 in electrical communication with the computer system 14 via communication path 18.

As a result of the separate collision domains, the MAC devices 28, 32 operate such that both can concurrently transmit packets and/or concurrently receive packets, or one of the MAC devices can receive packets while the other transmits packets, 15 without collisions occurring between networks.

Each MAC device 28, 32 includes buffer memory 30, 34 for storing packets prepared for transmission to the network 12 or packets received from network 12 via the communication paths 16, 18. The buffer memory 30, 34 includes a receive buffer 29, 34 and a transmit buffer 31, 35. In one embodiment, the buffer memory 30, 34 is sized to 20 store 8 or 16 bytes of data. The buffer memory 30, 34 can be internal or external to the MAC devices 28, 32. In one embodiment, each MAC device 28, 32 includes a buffer controller for handling packet transfers to and from the buffer memory. Other embodiments combine the controllers in a single component or incorporate the buffer

controller within the packet controller 24.

The memory 36 can be implemented using synchronous dynamic random access memory (SDRAM). Other types of memory devices can be used (e.g., SRAM). The organization of the memory 36 provides separate, dedicated memory sections 38, 5 44 for each of the MAC devices 28, 30. The separate sections 38, 44 operate to maintain the separate collision domains provided by the MAC devices 28, 30. Memory section 38 supports the MAC device 28 via signal lines 58 and the memory section 44 supports the MAC device 32 via signal lines 60.

The memory sections 38, 44 are each partitioned into a receive region 40, 46 10 and a transmit region 42, 48. Each receive region 40, 46 is partitioned into a specific block 41, 49 for storing packets addressed to the telephone set 10 and a general block 43, 51 for storing packets addressed to a device other than the telephone set 10. Each transmit region 42, 48 is partitioned into a priority block 45, 55 for packets having priority and a general block 47, 57 for non-prioritized packets.

15 Other ways of using the memory 36 to implement priority are contemplated. For example, the memory 36 can be organized as a buffer to store packets as the packets arrive at the telephone set. Rather than evaluate each packet as that packet arrives to determine the block of memory in which to store that packet, each packet can be directly stored in the memory 36 upon arrival and subsequently examined for 20 prioritizing when selecting a packet to forward to one of the I/O devices.

Each packet received by a MAC device from the network 12 includes the necessary information for determining the location in memory 36 to store the packet. Categories of packets include "telephone-specific," "telephone-general," or "general

other." The telephone set 10 uses (i.e., performs an action as prescribed by the information in the packet) telephone-specific and telephone-general packets. Examples of actions include converting packets with voice data into audio signals and outputting the audio signals to a local I/O device 17, displaying a message on the LCD, resetting error flags, setting the current time on an internal clock of the telephone set 10, and other housekeeping functions.

The telephone set 10 forwards telephone-general packets, but not telephonespecific packets, to the computer system 14. An example of telephone-general packets are those packets produced during a conference call. Both categories of packets, telephone-specific and telephone-general, are stored within the specific block 41, 49 of the receive region 40, 46. Packets that are general-other are stored in the general block 43, 51 and subsequently forwarded to the computer system 14. The telephone set 10 does not use such packets.

Figure 4 shows another embodiment 10' of the telephone set 10 in Figure 3. The telephone set 10' includes a packet controller 24' coupled to an input/output (I/O) port 26', a MAC interface 23, memory 36', and I/O control circuitry 50'. The MAC interface 23 is in electrical communication with a packet switching device 21 for forwarding packets between the network 12 and the computer system 14. In another embodiment, the MAC interface 23 can be removed to allow direct connection from the packet controller 24' to the switching device 21. The above descriptions for the packet controller 24, I/O port 26, memory 36, I/O control circuitry 50 in Figure 3 are the same as the corresponding components in Figure 4. The MAC interface 23 provides an interface that controls the communication between the network 12 and the

computer system 14 with the telephone set 10'.

The switching device 21 provides a function accomplished by the two MAC devices 28, 32 of Figure 3, which is to maintain separate collision domains for the network 12 and the computer system 14. The switching device 21 can be implemented using an NP313, a 3-port Fast Ethernet Integrated Circuit developed by NeoParadigm Labs, Inc. (NPL). The manner in which the switching device 21 can handle packets includes the following: the switching device 21 can forward a packet from the network 12 to the computer 14 (or in the opposite direction), the switching device 21 can ignore a packet received from either the network 12 or the computer 14; and the switching device 21 can use a packet to perform an action as prescribed by that packet, without forwarding the packet to either the network 12 or the computer 14.

A current impediment to the use of the switching device 21 is the costs associated with the hardware and software needed to implement the operation of the device 21 according to IEEE standards. This impediment can be eliminated over time if the costs of the switching device 21 decrease.

Figure 5 shows an exemplary embodiment of the packet controller 24. The packet controller 24 includes a timer 63, a digital signal processor (DSP) 64, a processor 66 (e.g., an ARM processor), a direct memory access (DMA) controller 68, control circuitry 70, an address table 72, and a memory controller 74 coupled to each other by a signal bus 76. Although shown separately, the timer 63 and the table 72 can be included within one of the other functional components 66, 68, 70, and 74.

The DSP 64 is in electrical communication with the I/O port 26 by signal lines 52. The memory controller 74 is in electrical communication with the memory 36 by

signal lines 78. The DMA controller 68 is in electrical communication with the MAC devices 28, 32 by signal lines 54, 56. In one embodiment, the memory controller 74 can be included in the DMA controller 68. Either the processor 66 or the DMA controller 68 can control the transfer of memory between the MAC devices 28, 32 and the memory 36.

The address table 72 stores addresses that are of importance to the telephone set 10. Examples of such addresses include the address of the telephone set 10, the identifier for a conference call, and a general broadcast address.

The DMA controller 68 accesses the table 72 whenever the telephone set 10 receives a packet to determine whether the telephone set 10 uses the packet as described above. When the packet has a destination address matching one of the addresses stored in the table 72, the telephone set 10 performs an action as prescribed by the packet. The telephone set 10 may or may not subsequently forward the packet to the network 12 or the computer system 14, as explained above.

In one embodiment, the table 72 also functions to filter out packets from subsequent forwarding by including addresses of the computer system 14. In this embodiment, the DMA controller 68 uses the addresses stored in the table 72 to discard, rather than forward, packets that are neither addressed to the telephone set 10 nor the computer system 14.

Destination addresses can be added to or removed from the table 72. For example, when a conference call starts, the processor 66 (or the DMA controller 68) stores the conference call identifier in the table 72 and removes the identifier when the conference call ends. Implementation of this table 72 can be in hardware or software,

but the lookup of addresses in the table 72 occurs faster when implemented in hardware in the described embodiment.

### Packet Forwarding Operation

The following description describes the packet forwarding process along a path from the network 12 and the MAC device 28 to the MAC device 32 and the computer system 14. However, it is to be understood that the process functions similarly in the reverse direction. When the MAC device 28 receives a packet, the MAC device 28 stores that packet in the receive buffer 29. The DMA controller 68 moves the received packet from the receive buffer 29 to the receive region 40 of the memory 36 and compares the destination address of the packet against the addresses stored in the address table 72. If the addresses match, then the telephone set 10 uses the packet, as explained previously.

When there is no address match or when the packet is a telephone-general packet, then the packet moves from the receive region 40 to the transmit region 42 for subsequent forwarding to the computer system 14. The processor 66 evaluates the packet to determine in which block, 45 or 47, of the transmit region 42 to place the packet. If the packet has priority, then the processor 66 places the packet in the priority block 45. If the packet has no priority status, then the processor 66 places the packet in the general block 47 or gives the packet a priority status and then places the packet in the priority block 45.

From the transmit region 40, the DMA controller 68 moves the packet to the transmit buffer 35 of the MAC device 32, which shifts the packet onto the

communication path 18 to the computer system 14. When processing a series of packets, the DMA controller 68 continually supplies the memory 36 with packets and keeps the transmit buffer 35 of the MAC device 32 full.

#### Packet Generating Operation

5 Figure 6 provides a flow chart describing a process by which the packet controller 24 constructs voice data packets from audio signals received by the I/O port 26. The generated packets can be unicast or multi-cast packets for use in an end-to-end telephonic communication or in a conference call. In step 78, the DSP 64 digitizes consecutive samples of audio signals and concatenates the digitized signals 10 into a data structure including voice data corresponding to the audio signals. When the data structure includes voice data generated from audio signal samples that span a predetermined duration, (e.g., 24 ms), the DSP 64 signals the processor 66 (Step 80). The processor 66 builds a frame around the data structure and produces, in one embodiment, an Ethernet packet. Because of the time-sensitive nature of voice data, 15 the processor 66 may add data to the data structure that indicate that the packet has priority. In step 82, the packet is queued in the priority block 45, 55, of the transmit section 42, 48. The DMA controller 68 subsequently passes the packet in the priority block 45, 55 to the MAC device 28, 32 for transmission as an Ethernet packet.

#### On-time Delivery

20 When moving packets from the memory 36 to the MAC devices 28, 32, the DMA controller 68 gives priority to packets stored in the priority block 45, 55.

Priority operates to increase the importance of certain packets so that such packets receive special treatment for getting onto one or both of the networks 12, 14. The ability of the telephone set 10 to concurrently forward non-prioritized packets and generate prioritized packets can produce occasions where a packet of low importance 5 is queued in a MAC device, waiting to be forwarded, when a time-sensitive voice packet is generated. For voice data to be useful, typically, such data must get to the destination within a certain time period (i.e., up to about 50 ms), whereas the critical period of time for delivery of control data is generally longer. Other types of data may not be time-sensitive. Rather than wait until the queued packet leaves the transmit 10 buffer of the MAC device, and risk reducing the usefulness of the voice data packet, the processor 66 can

preempt the transmission of that packet and replace that packet with the higher priority voice data packet. The processor 66 can discard the replaced packet, or store the packet until the voice transmission finishes, at which time the transmission of the 15 replaced packet resumes. Giving high priority to voice data packets facilitates on-time delivery of real-time data.

While the invention has been shown and described with reference to specific preferred embodiments, it should be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and 20 scope of the invention as defined by the following claims.

# WHAT IS CLAIMED IS:

1. A telecommunication conferencing system, comprising:  
at least three telecommunication devices connected to a network, each  
telecommunication device engaging in a concurrent telephonic communication and  
including:  
5 an I/O device in electrical communication with the network;  
an input device for producing audio signals;  
a packet controller in electrical communication with the I/O device and the  
input device, the packet controller (a) generating packets from the audio signals  
received by the input device, (b) forwarding the generated packets to the I/O device for  
10 transmission to the network, and (c) combining packets received by at least one of the  
I/O device and the input device for producing audio signals therefrom.
2. The telecommunication conferencing system of claim 1 wherein the packets  
generated from the audio signals received by the input device are unicast packets, the  
packet controller generating one of the unicast packets for each of the other  
telecommunication devices engaged in the concurrent telephonic communication.
3. The telecommunication conferencing system of claim 1 wherein the packets  
generated from the audio signals received by the input device are multi-cast packets.
4. The telecommunication conferencing system of claim 1 wherein the step of

combining comprises combining at least portions of packets received by at least one of  
the I/O device and the input device.

5. The telecommunication conferencing system of claim 1 wherein the step of  
combining comprises selecting at least a portion of one of the packets received by at  
least one of the I/O device and the input device.
6. The telecommunication conferencing system of claim 1 wherein each  
telecommunication device generates the combination from packets received from other  
telecommunication devices known by that telecommunication device to be engaged in  
the concurrent telephonic communication.
7. The telecommunication conferencing system of claim 1 further comprising:  
a second I/O device in electrical communication with a second network and the  
packet controller.
8. A telecommunication conferencing system, comprising:  
at least three telecommunication devices connected to a network, each  
telecommunication device engaging in a concurrent telephonic communication and  
receiving an identifier that is associated with the concurrent telephonic communication,  
5 each telecommunication device including:  
an I/O device in electrical communication with the network;  
an input device for producing audio signals;

a packet controller in electrical communication with the I/O device and the input device, the packet controller (a) generating multi-cast packets from the audio signals received from the input device, and (b) forwarding the generated multi-cast packets to the I/O device for transmission to the network, each generated multi-cast packet including the identifier associated with the concurrent telephonic communication.

9. The telecommunications conferencing system of claim 8 wherein the packet controller of each telecommunication device produces a combination of the multi-cast packets received from the other telecommunication devices engaged in the concurrent telephonic communication and generated at that telecommunication device.

10. The telecommunication conferencing system of claim 9 wherein the combination is a selected one of the multi-cast packets received from the other telecommunication devices engaged in the concurrent telephonic communication.

11. The telecommunication conferencing system of claim 8 wherein the I/O device of each telecommunication device communicates with the network via a first communication path, and each telecommunication device further includes a second I/O device in electrical communication with a second network via a second communication path.

12. The telecommunication conferencing system of claim 8 further comprising:

a second I/O device in electrical communication with a second network and the packet controller.

13. A method for conducting a concurrent telephonic communication among at least three telecommunication devices connected to a network, comprising the steps of:

receiving at one of the telecommunication devices voice data packets

5 transmitted by the other telecommunication devices conducting the concurrent telephonic communication;

generating at that one telecommunication device a combination of the received voice data packets;

generating at that one telecommunication device audio signals corresponding to  
10 the combination of the received voice data packets.

14. The method of claim 13 further comprising the steps of:

receiving audio signals at that one of the telecommunication devices;

generating from the received audio signals multi-cast packets having voice data  
corresponding to the received audio signals; and

5 forwarding the multi-cast packets to the network.

15. The method of claim 13 further comprising the steps of:

receiving audio signals at that one of the telecommunication devices;

generating from the received audio signals a unicast packet for each of the

other

5 telecommunication devices conducting the concurrent telephonic

communication, each unicast packet having voice data corresponding to the received audio signals; and

forwarding each generated unicast packet to the network.

16. The method of claim 13 further comprising the step of selecting only one of the voice data packets received from each of the other telecommunication devices to generate the combination.

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# AMENDED CLAIMS

[received by the International Bureau on 22 May 2000 (22.05.00); original claims 1, 8, 13, 14 and 15 amended; new claims 17 - 27 added; remaining claims unchanged (9pages)]

1. A telecommunication conferencing system, comprising:
  - a network;
  - at least three telecommunication devices connected to the network, each telecommunication device engaging in a concurrent telephonic communication and including:
    - an I/O device in electrical communication with the network for receiving and sending packets to other devices connected to the network;
    - an input device for producing audio signals from an input local to the device;
    - a packet controller in electrical communication with the I/O device and the input device, the packet controller (a) generating packets from the audio signals received by the input device, (b) forwarding the generated packets to the I/O device for transmission to the network, and (c) combining packets received by [at least one of] the I/O device and producing an audio signal with the combined packets and the audio signals from the input device.
2. The telecommunication conferencing system of claim 1 wherein the packets generated from the audio signals received by the input device are unicast packets the packet controller generating one of the unicast packets for each of the other telecommunication devices engaged in the concurrent telephonic communication.
3. The telecommunication conferencing system of claim 1 wherein the packets generated from the audio signals received by the input device are multi-cast

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packets.

4. The telecommunication conferencing system of claim 1 wherein the step of combining comprises combining at least portions of packets received by at least one of the I/O device and the input device.

5. The telecommunication conferencing system of claim 1 wherein the step of combining comprises selecting at least a portion of one of the packets received by at least one of the I/O device and the input device.

6. The telecommunication conferencing system of claim 1 wherein each telecommunication device generates the combination from packets received from other telecommunication devices known by that telecommunication device to be engaged in the concurrent telephonic communication.

7. The telecommunication conferencing system of claim 1 further comprising: a second I/O device in electrical communication with a second network and the packet controller.

8. A telecommunication conferencing system, comprising:  
at least three telecommunication devices connected to a network, each telecommunication device engaging in a concurrent telephonic communication and receiving a unique identifier that is associated with the telecommunication device engaging in the concurrent telephonic communication, each telecommunication

device including: an I/O device in electrical communication with the network; a local input device for producing audio signals; a packet controller in electrical communication with the I/O device and the input device, the packet controller (a) generating multi-cast packets from the audio signals received from the input device, and (b) forwarding the generated multi-cast packets to the I/O device for transmission to the network, each generated multi-cast packet including the identifier associated with each of the telecommunication devices engaging in the concurrent telephonic communication.

9. The telecommunications conferencing system of claim 8 wherein the packet controller of each telecommunication device produces a combination of the multi-cast packets received from the other telecommunication devices engaged in the concurrent telephonic communication and generated at that telecommunication device.

10. The telecommunication conferencing system of claim 9 wherein the combination is a selected one of the multi-cast packets received from the other telecommunication devices engaged in the concurrent telephonic communication.

11. The telecommunication conferencing system of claim 8 wherein the I/O device of each telecommunication device communicates with the network via a first communication path, and each telecommunication device further includes a second I/O device in electrical communication with a second network via a second communication path.



12. The telecommunication conferencing system of claim 8 further comprising: a second I/O device in electrical communication with a second network and the packet controller.
13. A method for conducting a concurrent telephonic communication among at least three telecommunication devices connected to a network, comprising the steps of:
- receiving at one of the telecommunication devices voice data packets transmitted by the other telecommunication devices conducting the concurrent telephonic communication;
  - receiving an audio signal from a local input and generating packets from the audio signal from the local input;
  - forwarding the generated packets from the audio signal from the local input from that one telecommunication device to the other telecommunication devices conducting the concurrent telephonic communication;
  - generating at that one telecommunication device a combination of the received voice data packets;
  - generating at that one telecommunication device audio signals corresponding to the combination of the received voice data packets and combining the audio signals corresponding to the combination of the received voice data packets with an audio signal from the local input.
14. The method of claim 13, wherein said step of receiving an audio signal from a local input and generating packets from the audio signal includes generating

from the received audio signals multi-cast packets having voice data corresponding to the received audio signals from the local input and forwarding the multi-cast packets to the network.

15. The method of claim 13 wherein said step of receiving an audio signal from a local input and generating packets from the audio signal includes generating from the received audio signals from the local input a unicast packet for each of the other telecommunication devices conducting the concurrent telephonic communication, each unicast packet having voice data corresponding to the received audio signals; and forwarding each generated unicast packet to the network.
16. The method of claim 13 further comprising the step of selecting only one of the voice data packets received from each of the other telecommunication devices to generate the combination.
17. The telecommunications conferencing system of claim 8 wherein each telecommunication device receives a list of participants based on the telecommunication devices participating in the concurrent telephonic communication, the packet controller of each telecommunication device forwarding or dropping packets without the identifier corresponding to the participants, and forwarding packets with the identifier corresponding to the participants to circuitry associated with the input device, the circuitry producing audio signals corresponding to the voice data in the packets.

18. The telecommunications conferencing system of claim 17 wherein the

list of participants is based on the identifier associated with each of the

telecommunication devices engaging in the concurrent telephonic communication.

19. An audio conferencing system comprising:

a network;

a first network device connected to the network;

a second network device connected to the network;

a third network device connected to the network, each network device

including a network input/output device for receiving packets from other devices

connected to the network and sending packets on the network, a local device with a

local sound input and a sound output, and a packet controller in electrical

communication with the input/output device and the local device, the packet

controller (a) generating packets from the audio signals received by the local sound

input, (b) forwarding the generated packets to the input/output device for

transmission to the network, (c) combining packets received by the input/output

device, and (d) producing audio signals based on the combined packets and the

audio signals from the local device.

20. The audio conferencing system according to claim 19, wherein the

packets generated by the packet controller are multi-cast packets from the audio

signals received from the input device, said packet controller forwarding the

generated multi-cast packets to the input/output device for transmission to the

network, each generated multi-cast packet including the identifier associated with

each of the telecommunication devices engaging in the concurrent telephonic

communication.

21. The audio conferencing system of claim 20 wherein each network

device receives a list of participants based on the network devices participating in

the concurrent telephonic communication, the packet controller of each network

device forwarding or dropping packets without the identifier corresponding to the

participants, and forwarding packets with the identifier corresponding to the

participants to circuitry associated with the input device, the circuitry producing

audio signals corresponding to the voice data in the packets.

22. The audio conferencing system of claim 21 wherein the list of

participants is based on the identifier associated with each of the network devices

engaging in the concurrent telephonic communication.

23. An audio conferencing system comprising:

a network;

a first network device connected to the network;

a second network device connected to the network;

a third network device connected to the network, each network device

including a network input/output device for receiving packets from other devices

connected to the network and sending packets on the network, a local device with a

local sound input and a sound output, and a packet controller in electrical

communication with an input/output device and the local device, the packet

controller a packet controller in electrical communication with the Input/output

device and the input device, the packet controller (a) generating multi-cast packets from the audio signals received from the input device, and (b) forwarding the generated multi-cast packets to the Input/output device for transmission to the network, each generated multi-cast packet including the identifier associated with each of the network devices engaging in the concurrent telephonic communication.

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24. The audio conferencing system according to claim 23, wherein the packet controller (c) generates packets from the audio signals received by the input device, (d) forwards the generated packets to the input/output device for transmission to the network, (e) combines packets received by the input/output device and (f) produces audio signals based on the combined packets in combination with audio signals from the local device.

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25. The method of claim 13, wherein the step of receiving an audio signal from a local input and generating packets from the audio signal includes using a packet controller to generate multi-cast packets from the audio signals received from a local input device, and forwarding the generated multi-cast packets to an input/output device of that one of the telecommunication devices for transmission to the network, the input/output device being connected to the network for transmitting packets over the network and receiving packets, each generated multi-cast packet including the identifier associated with each of the telecommunication devices engaging in the concurrent telephonic communication.

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26. The method of claim 25 wherein each network device receives a list of

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AMENDED SHEET (ARTICLE 19)

participants based on the network devices participating in the concurrent telephonic communication, the packet controller of each network device forwarding or dropping packets without the identifier corresponding to the participants, and forwarding packets with the identifier corresponding to the participants to circuitry associated with the local input device, the circuitry producing audio signals corresponding to the voice data in the packets.

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27. The method of claim 26 wherein the list of participants is based on the identifier associated with each of the network devices engaging in the concurrent telephonic communication.

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AMENDED SHEET (ARTICLE 19)

Fig. 2

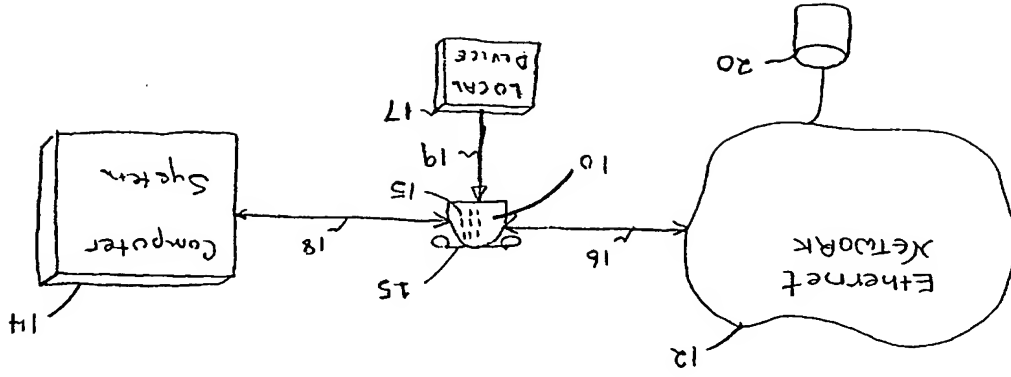


Fig. 1

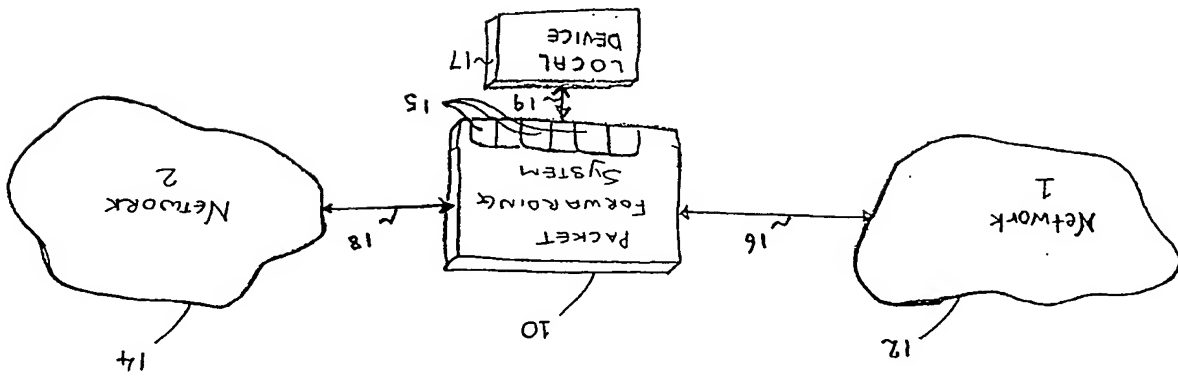


FIG. 4

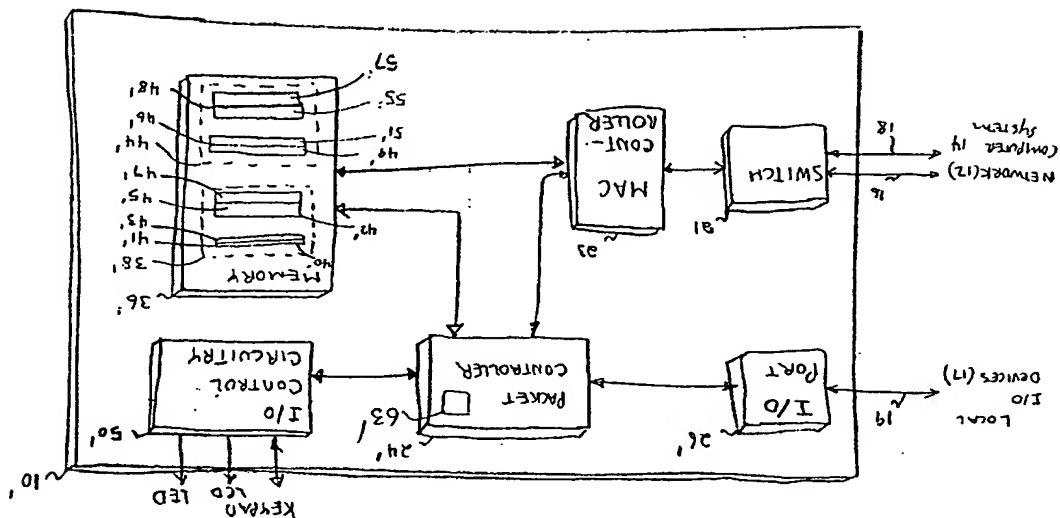
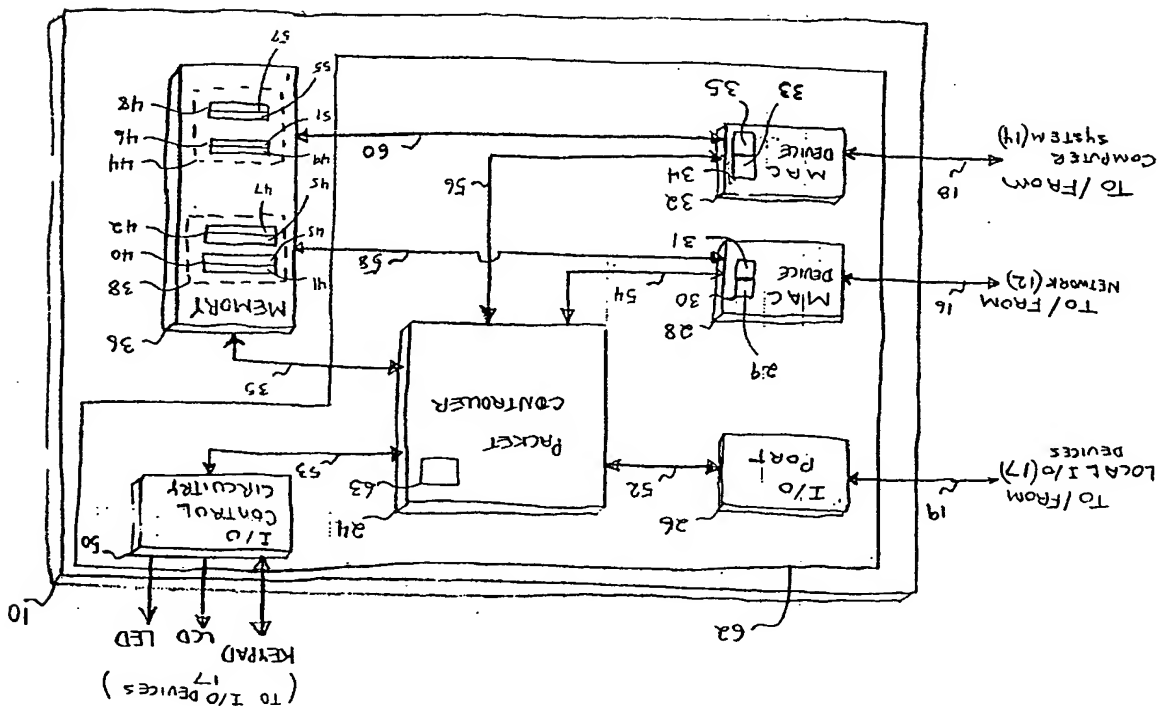


FIG. 3



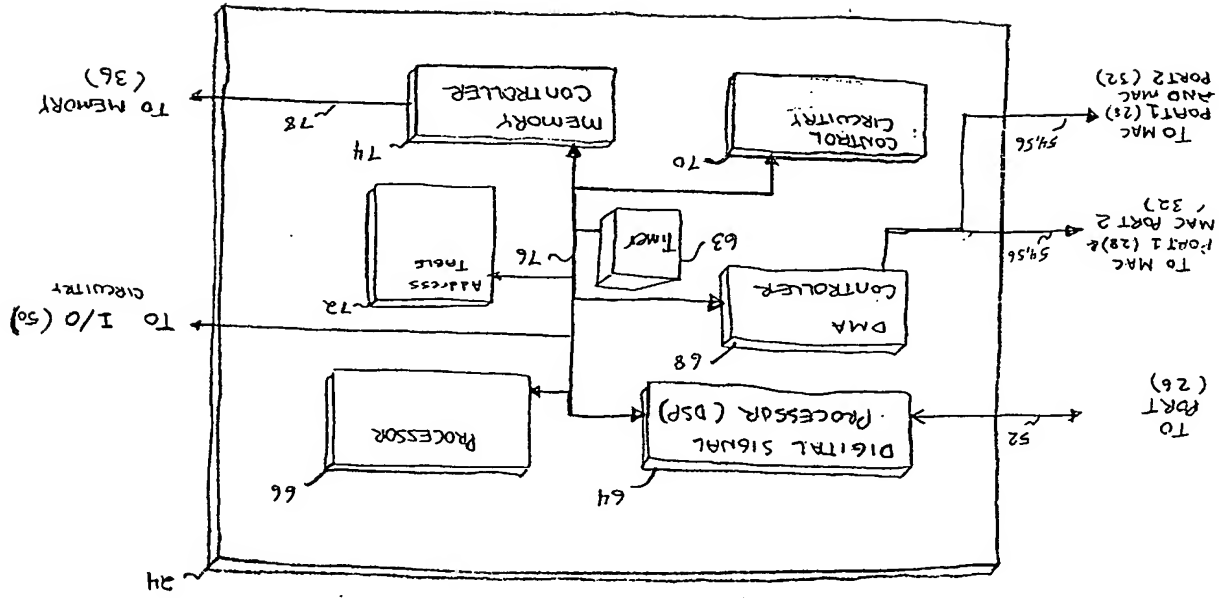


FIG. 5

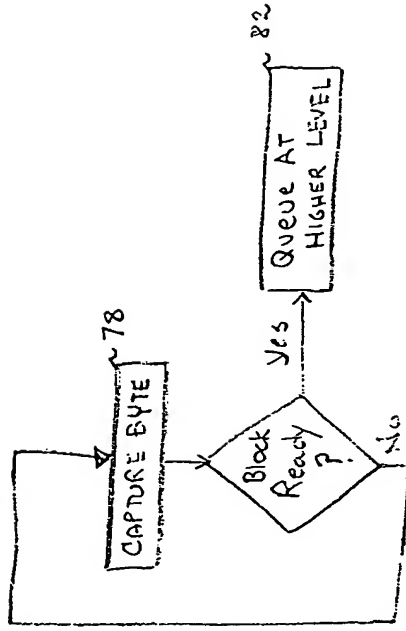


FIG. 6

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US99/28283

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : H04L 12/16, 12/28; H04Q 11/00  
US CL : 370/260, 266, 390

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 370/260, 261, 263, 265, 266, 352-356, 390, 432; 379/88.17

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EAST  
search terms: packet, multicast, conference

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	US 5,963,547 A (O'NEIL et al.) 05 October 1999, Figure 1.	1-13
Y	US 5,384,772 A (MARSHALL) 24 January 1995, Figure 1.	1-13
Y,P	US 5,973,724 A (RIDDLE) 26 October 1999, Figure 1.	1-13
X	US 5,729,532 A (BALES et al.) 17 March 1998, Figure 1.	1-13
Y	US 5,195,086 A (BAUMGARTNER et al.) 16 March 1993, Figure 1.	1-13

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

\* Special categories of cited documents:

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- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
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Date of the actual completion of the international search

28 FEBRUARY 2000

Date of mailing of the international search report

21 MAR 2000

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